



# Performance of Indian Mustard under the Fertility Levels and Cow Urine Application as Basal and Foliar Spray in Eastern Region of Uttar Pradesh

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

The experiment was laid out in split plot design assigning 18 treatment combinations of two fertility levels (75% and 100% RDF), three cow urine level (400,800,1200 l ha<sup>-1</sup>) as main plot and three spray level of cow urine (control, 25%, 50%) as sub plot with three replications. It was conducted at Varanasi during *rabi* season 2014 to evaluate effect of fertility levels and cow urine application as basal and foliar spray on growth and yield of Indian mustard. Results showed that increasing level of fertility up to 100% RDF significantly improved growth parameters, yield attributes, grain and straw yield. Among the cow urine levels, treatment 1200 l ha<sup>-1</sup> cow urine and 50% spray level of cow urine application proved superiority over other treatments, recorded significantly the highest, growth parameter, yield attributes, yield, gross returns, and net returns and B: C ratio.

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## 1. INTRODUCTION

Indian agriculture should be more knowledge-intensive to keep pace with the rising population pressure and decreasing land and energy resources. Presently, rapeseed-mustard is the most important group of oilseed crops after groundnut and soybean in India occupying 6.85 Mha acreage, 9.12 Mt production and 1331 kg/ha productivity (Ministry of Agriculture and Farmers Welfare, 2020). This crop accounts for about one-third of the vegetable oil produced in the country, making it the country's key edible oilseed crop. However, due to large gap between domestic availability and actual consumption of edible oils, India has to depend on import of edible oils. Rapeseed-mustard is grown predominantly in *rabi* season under energy starved condition in marginal lands and rainfed conditions. Nutrient management is one of the important constraints for mustard productivity. Nutrient supplied exclusively through inorganic sources though increased yield initially, but the sustainability was not maintained over the years. Intensive land use with imbalanced use of inorganic fertilizers without the addition of organic manures significantly influences soil health and crop growth. Under such situations, it is important to integrate the various possible sources of organic nutrients. Furthermore, their synergistic effect with chemical fertilizers for providing balanced nutrition and their use efficiency for long-term soil fertility, maintenance, productivity, and sustainability of agriculture is important for improvement in soil health and environmental safety.

Crop-livestock is the predominant farming system of India practiced over 70% of farm households. Cow urine which usually drains out as uncontrolled waste material and contributes to pollution has a good manurial value and can be utilized as a biofertilizer. [1]. Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite and sulphate [2]. Further, organic nutrient spray viz. cow urine at the critical growth stage of the crop, helps to overcome the problem of the slow release nutrients of organic sources affecting crop growth. Application of cow urine besides improving the soil texture and working as a plant hormone also been reported to correct the micronutrient deficiency, being organic in nature it also likely increase the fertilizer use efficiency [1]. Therefore, it seems that cow urine under

livestock based integrated farming system has a great potential for use as a bio fertilizer in crop production, both as soil application and foliar spray, and it needs to be studied on mustard under existing climatic condition. With these facts in view, a field trial was conducted to explore the possibility of economizing fertilizer use in mustard by partial replacement of fertilizer through cow urine as bio-fertilizer.

## 2. METHODS AND MATERIALS

A field experiment was conducted during winter (*rabi*) season of 2014-15 at the Agricultural Research Farm, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (UP). The experimental soil was sandy clay loam with poor in organic carbon (0.38%) and slightly alkaline in reaction (pH 7.7). The available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were 190.5, 18.5 and 180.3 kg/ha, respectively. The available N, P, K, S Ca and Mg content in cow urine used in the experiment were 0.976%, 0.09%, 1.1%, 0.08% 0.01% and 0.1%, respectively. The experiment was laid out in split plot design. The main plot treatment involved combination of two fertility levels i.e. 75% and 100% Recommended fertilizers dose (120kg N+ 60 kgP<sub>2</sub>O<sub>5</sub>+ 60kg K<sub>2</sub>O/ha) and three levels of cow urine as basal application i.e. 400, 800, 1200 l ha<sup>-1</sup>. The sub plot treatment comprised of three levels of cow urine as foliar spray (0%, 25% and 50%) applied @ 600 l ha<sup>-1</sup> at 30, 50 and 70 DAS. So, the total numbers of treatment combinations were eighteen which, were replicated thrice. Fertilizer application to the test crop was done as per treatment through urea, DAP, MOP and elemental sulphur respectively. Half dose of nitrogen, full doses of phosphorus, potassium and sulphur as per treatment were applied in furrows as basal dose. The rest dose of nitrogen was top dressed through urea at 30 days stage after first irrigation as per the treatment. Basal application of cow urine was done as per treatment with or without water just before sowing in furrows through rose can. However, foliar application of cow urine was given as per the treatment at 30, 50 and 70 DAS. Mustard crop variety 'Kalasona' was used @ 5.0 kg seed/ha at a row distance of 40 cm. The sowing was done in furrows, opened with the help of *kudal* and covered after sowing. Thinning of plants was done after 18 days of sowing in order to keep only one robust and healthy plant at a distance of 15 cm to maintain plant geometry at a spacing of 40 × 15 cm. Chemical weed control was carried out by

application of Pendimethalin 30EC@1 kg ha<sup>-1</sup> as pre emergence spray which was accompanied by one mechanical-cum-manual weeding at 4 week stage of the crop. One pre sown and one post sowing irrigation were applied maintain optimum soil moisture for plant growth.

### 3. RESULTS AND DISCUSSION

#### 3.1 Effect of Fertility Levels

The growth parameters viz. plant height, shoot dry weight, and leaf area index (LAI) were improved significantly by fertilizer applied at 100% RDF than 75% RDF (Table 1). Maximum chlorophyll content in terms of SPAD value at higher fertility level proved significantly superior to 75% RDF. Nutrient supply, in general, favorably influenced the growth attributes, supporting its well-established role in proper growth and development. As a result, plant height and production of branches and leaves also increased that resulted in higher shoot dry weight [3,4,5] also noticed a similar trend.

Fertilizer application showed marked influence on Yield attribute. Application of fertilizer at 100% RDF recorded significantly higher number of siliqua plant<sup>-1</sup>, siliqua length, seeds siliqua<sup>-1</sup> and Maximum test weight, over 75% RDF. Favorable effect of the application of 100% RDF on growth and yield contributing factors was reflected on need and stover yield. Application of 100 % RDF produced 15.1 and 18.2% higher seed and stover yield, respectively over 75 % RDF. Under higher fertility levels more efficient mobilization of photosynthates to reproductive attributes is bound to occur which leads to resulted in bigger siliqua and more numbers of seed which on maturity becomes bold with higher test weight. These results are in accordance with the findings of Bohra et al. [6]; and Paliwal and Singh [7]. Application of 75% RDF recorded significantly higher harvest index as compared to 100% RDF. This shows that 75% RDF utilized the applied nutrients at higher level of efficiency towards the seed than stover yield. These results are in conformity with the finding of Ghimire and Bana [8] and Verma et al. [3].

#### 3.2 Effect of Soil Application of Cow Urine

Increasing levels of application of cow urine from 400 to 1200 l ha<sup>-1</sup> markedly influenced growth characters like plant height, leaf area index and shoot dry weight plant<sup>-1</sup>. However, the variations

were more pronounced between 400 and 1200 l ha<sup>-1</sup>urine application. This could be attributed to the higher content N in cow urine which might have favoured protein synthesis and thereby higher photosynthesis, K, the other major constituent of cow urine (0.11 ppm) as an activator of enzymes regulates carbohydrate metabolism and protein synthesis and eventually the growth. Leaf chlorophyll content through increased with increasing levels of cow urine application, the differences failed to touch the level of significance.

Cow urine applied as basal application enhanced improved the yield attributing characters of mustard. It was noted that increase in urine levels from 400 to 1200 l ha<sup>-1</sup> correspondingly enhanced the number of siliqua plant<sup>-1</sup>, seeds siliqua<sup>-1</sup>, 1000 seed weight and seed yield plant<sup>-1</sup> (Table 1). Nitrogen is one of the essential constituents of cow urine, which has been reported to enhance the process of tissue differentiation, cell multiplication, cell growth *i.e.* from somatic to reproductive phase, meristematic activity and improvement of floral primordia leading thereby to increased flowering and finally the fruit setting. However, the harvest index and siliqua length could not confirm variable response to urine application. The findings are conformity with the findings of Vahanka et al. [9]; Singh et al. [10].

Marked effect of soil application of cow urine was observed on need and stover yield. However, the difference between 400 and 800 l ha<sup>-1</sup> did not turning significant both for need as well as stover yield. Higher urine levels produced taller plants and increased number of functional leaf plant<sup>-1</sup>, accumulation of dry matter plant<sup>-1</sup>, siliqua plant<sup>-1</sup>, seeds siliqua<sup>-1</sup>, and 1000 seed weight which ultimately resulted into higher grain and stover yield. The results are in agreement with the findings of Mohanty et al. [11], Oliveira et al. [12], Singh et al. [10].

#### 3.3 Effect of Foliar Spray of Cow Urine

In present investigation, lucid effect of foliar application of Cow urine was observed on growth attributing characters of mustard viz. plant height, chlorophyll content (SPAD), LAI, dry weight of shoot plant<sup>-1</sup> at all the stages of crop growth during the experimentation. The effect of urine application as foliar spray on growth attributing characters was significant mostly between 50% urine spray and control at all the growth stages. Urine spray has been found to bring rapid

Table 1. Effect of fertility levels and cow urine application as basal and foliar spray on growth and growth contributing characters of mustard

Treatment	Plant height	Shoot dry weight/plant(g)	LAI(70 DAS)	Chlophyll (70 DAS)	Siliqueaplant <sup>-1</sup>	Siliqua length (cm)	Seeds siliqua <sup>-1</sup>	1000-seed weight(g)
<b>Fertility levels</b>								
75% RDF	165	18.6	3.05	37.5	129	4.90	12.6	4.50
100% RDF	169	22.0	3.23	39.3	138	5.04	13.3	4.73
<b>S. Em±</b>	<b>1.4</b>	<b>0.69</b>	<b>0.03</b>	<b>0.4</b>	<b>2.1</b>	<b>0.04</b>	<b>0.16</b>	<b>0.06</b>
<b>C.D. 5%</b>	<b>4.4</b>	<b>2.18</b>	<b>0.09</b>	<b>1.3</b>	<b>6.5</b>	<b>0.12</b>	<b>0.51</b>	<b>0.17</b>
<b>Urine levels (l ha<sup>-1</sup>)</b>								
400	163	18.3	3.02	37.8	127	4.92	12.3	4.46
800	167	20.6	3.16	38.4	132	4.96	13.0	4.69
1200	169	22.0	3.24	39.1	142	5.03	13.5	4.69
<b>S. Em±</b>	<b>1.7</b>	<b>0.85</b>	<b>0.03</b>	<b>0.5</b>	<b>2.5</b>	<b>0.05</b>	<b>0.20</b>	<b>0.07</b>
<b>C.D. 5%</b>	<b>5.4</b>	<b>2.67</b>	<b>0.11</b>	<b>NS</b>	<b>8.0</b>	<b>NS</b>	<b>0.62</b>	<b>0.21</b>
<b>Urine spray</b>								
Control	164	18.8	3.07	37.7	129	4.91	12.2	4.52
25%	166	20.2	3.13	38.4	132	4.97	13.1	4.55
50%	170	22.0	3.22	39.3	140	5.04	13.6	4.78
<b>S. Em±</b>	<b>0.8</b>	<b>0.66</b>	<b>0.03</b>	<b>0.4</b>	<b>1.6</b>	<b>0.04</b>	<b>0.25</b>	<b>0.07</b>
<b>C.D. 5%</b>	<b>2.4</b>	<b>1.91</b>	<b>0.09</b>	<b>1.3</b>	<b>4.6</b>	<b>0.11</b>	<b>0.72</b>	<b>0.20</b>

Table 2. Effect of fertility levels and cow urine application as basal and foliar spray on yield and economics of mustard

Treatment	Seed yield (kg ha <sup>-1</sup> )	Stover yield (kg ha <sup>-1</sup> )	H.I. (%)	Gross Return (Rs. ha <sup>-1</sup> )	Cost of Cultivation (Rs. ha <sup>-1</sup> )	Net return (Rs. ha <sup>-1</sup> )	B:C ratio
<b>Fertility levels</b>							
75% RDF	1129	3627	23.7	48080	31566	16514	1.52
100% RDF	1299	4286	23.3	55385	33382	22004	1.66
<b>S. Em±</b>	<b>24.5</b>	<b>77.8</b>	<b>0.07</b>	<b>1040</b>	-	<b>1040</b>	<b>0.03</b>
<b>C.D. 5%</b>	<b>77.1</b>	<b>245.1</b>	<b>0.23</b>	<b>3277</b>	-	<b>3277</b>	<b>0.10</b>
<b>Urine levels (l ha<sup>-1</sup>)</b>							
400	1132	3717	23.4	48273	31827	16446	1.51
800	1205	3918	23.5	51354	32483	18870	1.58
1200	1305	4235	23.6	55572	33111	22461	1.68
<b>S. Em±</b>	<b>30.0</b>	<b>95.3</b>	<b>0.09</b>	<b>1274</b>	-	<b>1274</b>	<b>0.04</b>
<b>C.D. 5%</b>	<b>94.4</b>	<b>300.2</b>	<b>NS</b>	<b>4013</b>	-	<b>4013</b>	<b>0.12</b>
<b>Urine spray</b>							
Control	1189	3862	23.6	50636	31987	18648	1.58
25%	1204	3938	23.4	51306	32483	18823	1.58
50%	1250	4070	23.5	53256	32950	20306	1.61
<b>S. Em±</b>	<b>12.7</b>	<b>40.2</b>	<b>0.11</b>	<b>536</b>	-	<b>536</b>	<b>0.02</b>
<b>C.D. 5%</b>	<b>37.2</b>	<b>117.4</b>	<b>NS</b>	<b>1565</b>	-	<b>1565</b>	<b>NS</b>

changes in phenotypes of plants and also improve the growth and productivity. The biochemical contents viz. carbohydrates, protein, and amino acids found in plants sprayed with cow urine was more irrespective of the concentration which leads to enhance growth attributes, from 400 to 1200 l ha<sup>-1</sup> probably due to better supply of nitrogen at higher rates of urine application.

Urine applied as foliar spray also enhanced the yield contributing characters viz. siliquae on main shoot, siliqua plant<sup>-1</sup>, seeds siliqua<sup>-1</sup>, siliqua length, 1000 seed weight and seed yield plant<sup>-1</sup> (Table 1). The significant improvement in dry matter accumulation, chlorophyll content and nitrogen content described above may be ascribed to better yield attributes under 50% cow urine spray. Foliar spray of cow urine at the rate of 50% recorded significantly highest seed yield and stover yield as compared to control. The increase in seed and stover yield at higher concentration of cow urine produced taller plants and increased number of functional leaf plant<sup>-1</sup>, accumulation of dry matter plant<sup>-1</sup>, siliqua plant<sup>-1</sup>, seeds siliqua<sup>-1</sup>, and 1000 seed weight which ultimately resulted into higher grain and stover yield. The results are corroborated with the research findings of Verma et al. [3], Mohanty et al. [11], Oliveira et al. [12], Singh et al. [1].

### 3.4 Comparative Economics

The differences in gross return under various fertility and urine levels as basal as well as foliar spray were mainly due to the differences in seed and stover yield. Whereas, the cost of cultivation varied due to different quantities of fertilizer and urine applied. The Gross and net return were significantly higher at higher fertility level. Benefit: cost ratio also followed the similar trend. This shows that 100% RDF was more remunerative over the lower level of fertility (75% RDF). Gross return was increased with increasing levels of soil urine application from 400 to 1200 l ha<sup>-1</sup>. Nevertheless, for net return the difference was significant only between 400 and 1200 l ha<sup>-1</sup>. This shows that application of cow urine is remunerative at 1200 l ha<sup>-1</sup>. Similar trend was noticed for B: C ratio indicating that basal application of cow urine even at the highest rate of application was utilized efficiently. Foliar application of cow urine at 50% concentration enhanced the gross and net return over control indicating that foliar application of cow urine at 50% was remunerative. The results are in agreement with the findings of Verma et al. [3],

Mohanty et al. [11], Oliveira et al. [12], Singh et al. [10].

## 4. CONCLUSION

Nutrient supplied exclusively through inorganic sources though increased yield initially, but the sustainability was not maintained over the years. Intensive land use with imbalanced use of inorganic fertilizers without the addition of organic manures significantly influences soil health and crop growth.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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